

LETTERS TO THE EDITOR.

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The Presence of Water Vapour in the Atmosphere of Mars.

IN February and March, 1908, Mr. V. M. Slipher succeeded in photographing the lines due to water vapour in the atmosphere of Mars. It was in the "a" band that its presence stood revealed. The detection was rendered possible by the use of plates specially prepared by him for the purpose—23 Seed, bathed in a mixture of pinacyanal, pinaverdol, dicyanin, water, and ammonia—which enabled the spectrum to be photographed somewhat beyond the "A" band. Comparison spectrograms were made of the moon at approximately the same altitude on the same plates, and with exposures to give a like density for both. Repeated plates of the sort were taken, and their consensus shows unmistakably the "a" band stronger in the spectra of the planet than in those of the moon. In the case of the moon, of course, we are looking through our own atmosphere only; in the case of the planet, through its atmosphere as well.

Previous observers—Huggins, Jansen, Vogel, Campbell—had reached discordant conclusions, Huggins and Vogel asserting the presence of water vapour in the atmosphere of the planet, Campbell with much improved spectroscopic means failing to get any indication of it. The reason of this was the instrumental inability at the time these researches were made to examine the spectrum sufficiently far into the red, for it is in the "a" band that the greatest absorption of water vapour occurs, and this was not only beyond the possibility of photography at the time, but beyond even that of visual detection. Thus Vogel went no further redwards than "C," while Campbell tells us in his account of his researches, in which he came to a negative conclusion:—"It is impracticable to observe the groups A, 7450 to 7160 and 7160 to 6870, which are at the extreme red end of the spectrum, and they will not be further considered." In this omission, rendered necessary by the instrumental appliances at the time, lay the failure to perceive the evidence of water vapour in the spectrum of the planet. For, as the following table shows, the intensity of the absorption is much greater in the "a" band than in the lines between it and the D lines, or even in those near the D lines themselves. This is borne out by examination of Mr. Slipher's plates, in which the difference in the "a" band is evident, the broadening of the D lines just perceptible, and nothing predicable of the fainter water-vapour lines.

Relative Strength of the Water-vapour Lines in the Spectrum, according to Rowland.

Substance	Determination 1893.				Determination 1895.				Wave- length
	Strength								
	Lines probably identified		Lines certainly identified						
A 7604 ... Oxygen ...	120	120	—	—	7672	7594			
a 7165 ... Water Vapour ...	124	50	128	—	7319	7176			
„ ...	9	—	6	—	7016	6999			
„ ...	42	13	54	—	6948	6936			
B 6867 ... Oxygen ...	170	—	—	—	6867	6572			
C 6562 } Solar, H) } Water Vapour ...	5	5	20	—	6480	6296			
a Oxygen ...	14	—	—	—	6278	5977			
Water Vapour ...	2	2	10	—	5920	5884			
D ₁ 5896 } D ₂ 5890 } (Solar, Na) }	26	26	68	—	5884				

No water vapour lines of less wave-length than 5884.

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The great dryness of Arizona was no less a factor in the result. So dry was the air at times during the investigation that on more than one plate the "a" band is hardly to be made out in the lunar spectra, while in the Martian it is unmistakable. Great dryness in the climate is in other ways shown by the plates to be essential to the recording of a perceptible difference between the water-vapour lines due to Mars and the earth and those due to the earth alone. For examination of the oxygen bands, A, B, and α , in the two spectra reveals no perceptible difference between them, and yet the presence of water vapour in the spectrum of Mars is strong presumptive evidence that free oxygen exists in its atmosphere as well, since it is the heavier of the two.

PERCIVAL LOWELL.

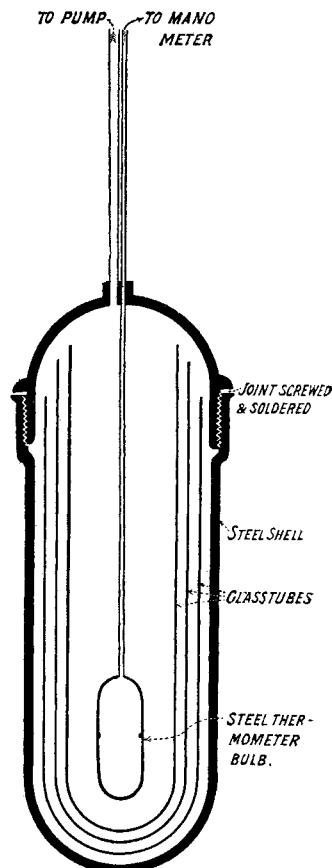
Lowell Observatory, Flagstaff.

The Condensation of Helium.

I HAVE just read with great interest of Prof. Onnes's experiments with helium, and as one who has carried out investigations at very low temperatures, and to a certain extent in the same direction, I must congratulate him on having overcome difficulties of no ordinary nature. At the time of my departure for India I was engaged in an attempt to measure temperatures below the temperature of solid hydrogen, with the ultimate object of determining thermal constants for helium, but the work was broken off when I left Bristol, and it is not likely that I shall be able to resume it for some time. However, it is possible that brief information as to the method I intended to employ may be of use to others.

The measurement of low temperatures by any means other than by the gas thermometer appeared to me to be mere waste of time, and I decided to employ in these experiments a constant volume helium thermometer. Following the method of Olszewski, I proposed to compress helium to about 100 atmospheres in a vessel cooled in solid hydrogen, and containing the thermometer, and to measure the fall of temperature on expanding the gas. The only obvious difficulty lay in the construction of the apparatus.

The apparatus shown about natural size in the figure was made for me by Messrs. A. Hilger. The outer vessel was of thin steel, and had a capacity of about 40 c.c. Within were three concentric test-tubes, made as light as possible, and separated one from the other and from the steel vessel with fragments of cork. In the centre is a very light bulb of steel, to which was soldered a capillary steel tube such as is used for hypodermic needles. This bulb was intended to serve as a thermometer, the steel tube communicating with the manometric portion of one of the thermometers which I employed in the measurements of the temperatures of liquid and solid hydrogen (Phil. Trans., cc. A, 105, 1902). A steel tube connected the steel vessel



with the pump, &c. A steel gasometer floating on mercury, and a steel pump working with mercury as a lubricant, had also been constructed for me by Messrs. Brin's Oxygen Co. Sir William Ramsay had placed a large quantity of helium at my disposal.

Preliminary experiments with oxygen led me to the conclusion that by this method it would be possible to attain to, and measure temperatures far below, the melting point of hydrogen. I may point out that for very low temperatures the reading of the manometer attached to the thermometer would give a direct measurement of the temperature, as the dead space correction would be very small.

MORRIS W. TRAVERS.

Indian Institute of Science, Bangalore, March 29.

The Radio-activity of Ordinary Metals: the Penetrating Radiation from the Earth.

In a paper in the *Phil. Mag.*, December, 1907, I described some experiments made by me on the conductivity of air confined in metallic cylinders, 60 cm. long and 24 cm. in diameter, which were made of lead, of zinc, and of aluminium. With the zinc and aluminium carefully cleaned, a conductivity was obtained for the enclosed air, which on reduction gave the value 15 for q , the number of ions generated per c.c. per second in the air. With lead cylinders, which were investigated more extensively than those of other metals, the conductivity exhibited wide variations, and values were obtained which ranged from 160 to 23 ions per c.c. per second.

During the past eight months experiments on the conductivity of air confined in metallic vessels have been continued in the Physical Laboratory at Toronto by Mr. C. S. Wright, and he has now obtained under normal conditions with a particular lead cylinder of the dimensions given above, in a series of observations made in a room in the laboratory, a conductivity corresponding to the production of 15.3 ions per c.c. per second. With zinc and aluminium cylinders, the lowest conductivities obtained in this room by him correspond, respectively, to the values 13.4 and 12.5 ions per c.c. per second for q .

He has also, during this period, conducted a series of experiments on the conductivity of air enclosed in these cylinders in and about Toronto, and has found that the conductivity of the enclosed air varied considerably with the character of the soil and rocks in the neighbourhood of the points of observation.

In making measurements on the ice above the water of Lake Ontario, the conductivity was found to be very much lower over the surface of the water than at points on the land on either side of the lake at some distance from the shore. In these experiments on the ice the values 8.6, 6.0, and 6.55 ions per c.c. per second were found for q with cylinders of lead, zinc, and aluminium respectively, and in a more extended series of observations with the lead cylinder alone, the conductivity was found to be the same over water with depths varying from 2.5 to 10 metres. Measurements were also made on board the steamer *Corona* during one of her passages over the lake, and values were obtained for q uniformly lower by approximately 6 ions per c.c. per second than those found in the laboratory at Toronto, although the depth of the water at the wharf in Toronto, where the observations in this series were commenced, was not more than 6 or 7 metres, while it was approximately 150 metres in depth at the deepest point on the line of passage.

Observations made on a sand bar extending out into the lake near Toronto gave a value of 9 ions per c.c. per second for q , and others made on land, at some distance from the shore, at various points and over different soils, gave values ranging from 11.2 to 15 ions per c.c. per second.

From the investigation it would appear that the water of Lake Ontario, as well as the sand along the shore line, contains little, if any, radio-active materials, and consequently does not contribute any appreciable proportion of the penetrating radiation observed at points on the earth's surface.

It would appear, too, from the constancy of the observed

drop in conductivity that the water of the lake completely screens off any radiation coming from the soil or rock beneath it. In order to confirm this view, some experiments were made on the absorbing power of the water for the γ rays from radium. Thirty milligrams of radium bromide were enclosed in a brass tube with walls about 1 cm. thick. This tube was laid on the ice, and the ionisation chamber placed 113 cm. above it. With this arrangement it was found that the conductivity added by the radium bromide corresponded to the generation in the air in the chamber of 4485 ions per c.c. per second. A hole was then made in the ice, and the tube was lowered to different depths in the water beneath, the conductivity being measured for each position of the radium. At a distance of half a metre below the surface the conductivity corresponded to the production of 447.2 ions per c.c. per second, at 1 metre to 16.11, at 2 metres to 0.69, and at 3 metres to 0.62 ions per c.c. per second. From these numbers it will be seen that a layer of water between 2 and 3 metres in thickness sufficed to absorb practically all the radiation issuing from the radium in the tube.

In view of these experiments and of those of Elster and Geitel, who observed a fall of 28 per cent. in the conductivity of air enclosed in an aluminium cylinder, on taking this cylinder from the surface of the earth to the bottom of a mine surrounded with a wall of rock salt, it would seem that the penetrating radiation observed by a number of investigators at the surface of the earth is more or less local in character, and that, while its existence may be traceable to active substances present in the soil and rocks, the effective intensity is largely determined by the amount of inactive substances it may have to pass through in order to reach the surface.

The extremely low values found for q with the cylinders of lead, zinc, and aluminium in the experiments on the ice are interesting on account of their uniformity. They are, as is evident, of the order of magnitude of effects which might easily be accounted for by active impurities in the metals, since differences as large as these values of q may easily be obtained with cylinders made from different samples of almost any metal selected at random. Considering also the difference in the atomic weights of the three substances aluminium, zinc, and lead, and having in mind that radio-activity is a property associated with atomic structure, it would seem that if these metals could be obtained entirely free from active impurities, and the conductivity of air contained in vessels made from them studied, it would be found, if the observations were carried out under conditions or in places where no ionisation was possible from penetrating radiations arising from external sources, to drop to a very low value, if it did not entirely vanish.

The experiments described in this note were made with one of Mr. C. T. R. Wilson's latest type of gold-leaf electrometers, which was found, on account of its portability, and of the facility and exactness with which readings could be made with it, to be most admirably suited to the purposes of the investigation.

J. C. McLENNAN.

Physical Laboratory, University of Toronto,
March 30.

The Theory of Dispersion and Spectrum Series.

ON p. 413 of NATURE (March 5) Prof. Schott attempts to show that there is an irreconcilable inconsistency between Drude's dispersion formula and Balmer's formula for the lines in the hydrogen spectrum. I imagined that someone who could speak with greater authority than myself would make the obvious reply, but since no such reply has been forthcoming, and the arguments have been republished in another journal, I venture to ask for space to point out why they appear to me fallacious.

Prof. Schott's error consists in assuming that the λ_h in Drude's formula is the same as the λ , in Balmer's formula. The λ_h in Drude's formula is the wave-length of the light for which the medium shows selective absorption; that in Balmer's formula is the wave-length of the light emitted by the gas when in a luminous state. An unintelligent